REPLACED BY ART 34 AMDT

CLAIMS

1. An apparatus (1) to assist a patient respiration by delivering air to a patient trough a mask, said mask being designed to be connected on one first extremity of a tube, said apparatus comprising :

- a control unit (2) to adjust the pressure delivered by the blower (4) of said apparatus,
- a first pressure sensor (6) for sensing the pressure PM at said first tube extremity and being connected to said control unit, and
- a second pressure sensor (8) for sensing the pressure PB at the air output of said blower and being connected to said control unit;

in order that, when a tube is connected to said mask and connected to said apparatus on its said second extremity, the air flowing from the apparatus to the mask, said control unit is able to calculate the airflow at said second extremity of the tube from said pressures PM and PB and from the airflow resistance coefficient K_T of said tube.

2. The apparatus according to claim 1, wherein when at least one filter (22) is placed at one tube's extremity, said control unit (2) is able to calculate the airflow at said second extremity of the tube (20) from these measured pressures PM and PB and from the airflow resistance coefficient K_T of said tube and from the airflow resistance coefficient K_F of said filter.

3. The apparatus according to claim 1 or 2, wherein when a tube is connected between said apparatus (1) and a shell (10) with a traversing hole (12) having a known airflow resistance coefficient K_S, the air flowing from the apparatus to said shell, the measured pressures PM and PB are send to said control unit (2) which calculates the tube airflow resistance coefficient K_T from these measured pressures and from the said coefficient K_S.

REPLACED BY ART 34 AMDT

4. An apparatus according to any one of claim 1 to 3, wherein said control unit (2) comprises a non volatile memory in which the control unit stores, as a couple of values, the two pressures PM(J) and PB(J), measured at each said pressure sensors (6 and 8) when said control unit forces the blower to deliver a determined constant pressure I at one of the two sensors (6 or 8), so that when at least two couples of pressures corresponding to two different said determined constant pressure I are stored, the control unit is able to calculate an average of said coefficient K_T.

5. The apparatus according to any of the previous claims, wherein the control unit (2) comprises offset compensation means for compensating the possible difference of gauging between the two pressure sensors (6 and 8).

6. An apparatus (1) according to claim 5, wherein said offset compensation means comprise :

- a microprocessor (30)
- a digital to analog converter (32) connected to said microprocessor (30) in order to convert microprocessor's digital data in analog data,
- an analog subtractor (34) having inputs connected to the second pressure sensor (8), to the first pressure sensor (6), and to said digital to analog converter,

said microprocessor calculating, when the blower is not functioning, the difference between the two pressures measured by said first and second pressure sensors and then sending the value C of this difference to said digital to analog converter, which converts said value C in analog data and drive it to said analog subtractor, which subtract the pressure PB measured by said second pressure sensor and said value C to the pressure PM measured by said second pressure sensor and send the corresponding result D to the microprocessor, which will modify the C value until said D result equals zero, said microprocessor capturing the C value when said D result equals zero, enabling the control unit to correct the difference of offsets between the pressure sensors.

REPLACED BY
ART 34 AMDT

7. An apparatus according to claim 6, further comprising an analog amplifier (36) connected to said analog subtractor (34) in order to amplify the signal corresponding to said D result and to send it to said microprocessor (30), thus enabling said microprocessor to have an accurate adjustment of said value C until said result D reaches the value zero.

8. An apparatus according to claim 7, further comprising analog to digital converters (42, 44 and 40) connected between the microprocessor (30) and the said first pressure sensor (6), between the microprocessor and the said second pressure sensor (8), and between the microprocessor and the said analog amplifier (36), so that the microprocessor is provided with only digital data.

9. Process for calibrating a tube used in apparatus to assist patient's respiration by using the apparatus (1) according to any of claim 1 to 5, said process comprising :

- connecting a first tube's (20) extremity to the blower (4) of said apparatus,
- connecting said first pressure sensor (6) to measure the pressure PM at a second tube's extremity,
- connecting said second extremity to a shell (10) with a traversing hole (12) having a known airflow resistance coefficient K_S,
- switching the blower on,
- instructing said control unit (2) to measured the pressures on said first pressure sensor and on the second pressure sensor (8), which is measuring the pressure PB at the blower's apparatus outlet, and
- calculating the value of the tube airflow resistance coefficient K_t from these measured pressures PM and PB and from the said coefficient K_s.

10. Process for calibrating the tube used in apparatus to assist patient's respiration, and for calibrating the tube by using the apparatus (1) according to any of claim 1 to 5, said process comprising :

- connecting a first tube's (20) extremity to the blower (4) of said apparatus,

- connecting said first pressure sensor (6) to measure the pressure PM at a second tube's extremity,
- connecting said second extremity to a shell (10) with a traversing hole (12) having a known airflow resistance coefficient K_S,
- switching the blower on,
- fixing at a value I the pressure provided and measured on one pressure sensor,
- instructing said control unit (2) to measured the pressures on said first pressure sensor and on the second pressure sensor (8), which is measuring the pressure PB at the blower's apparatus outlet,
- storing these measures PM(J) and PB(J) as a couple of measures associated to said value I,
- repeating a number of time N the steps 5 to 6 of said process, said value I being different for each time, so that each couples of pressures is associated with one value I,
- calculating (20) on average of the airflow resistance coefficient K_T from these measured pressures PM and PB and from the said coefficient K_S.

11. The apparatus according to claim 1 to 8, wherein said pressure control unit (2) comprises an estimation module (100) connected to the means for detecting the patient's breathing parameters (110), in order that the estimation module is able to determine when the patient is inspiring or expiring and in response the pressure to apply to the patient's mask, so that the control unit adjust the pressure delivered by the blower.

12. The apparatus according to claim 11 or 12, wherein the control unit comprises a non volatile memory (120) in which the clinician can enter clinical settings (120 comprising at least the treatment pressure and possibly the pressure to apply according to the patient's breathing parameters, said estimator applying the pressure according to these clinical settings and to the patient's breathing parameters.

13. The apparatus according to claim 13, wherein the patient can enter patient settings (122) in said non volatile memory, said estimator applying the pressure according to these patient settings and to the patient's breathing parameters within bounds given by the clinician settings.

14. The apparatus according to any one of claim 11 to 14, in which the estimation module 100 is able to determine that an event (E_1, E_2 or E_3) occurs in patient's breathing thus enabling said control unit to adjust the tension to apply to the blower to adjust the pressure at patient's mask.

15. The apparatus according to any one of claim 11 to 15, wherein said means (6) for detecting the patient's breathing parameters enable the control unit (2) to compute the airflow at patient's mask (20), said comparator determining that an event (E_1, E_2 or E_3) is occurring with the airflow parameters or shape.

16. The apparatus according to claim 11 to 17, wherein said estimation module has an inspiration out put (102) where said estimation module set the mask pressure PM value during inspiration and wherein said estimation module has an expiration out put (102) where said estimation module set the mask pressure PM value during expiration, said control unit comprising a switch which is connected alternatively to the inspiration out put (102) or expiration out put (102) according to patient's breathing.

17. The apparatus according to claim 11 to 18, wherein the apparatus further comprise a starting mean which when actuated enables the estimation module (100) to determine if a breathing activity is detected, the estimator module sending the instruction to stop the blower if no activity is sensed after a given delay.

18. The apparatus according to any one of the previous claim, further comprising a Frequency Shift Keying (FSK) modulator 50 which transforms the binary data send by the apparatus sensors or elements in a modulation of the frequency of the tension applied on a voltage controlled current source 52, connected to the external power supply, so that the

REPLACED BY ART 34 AMDT

voltage controlled current source 52 transmit the modulation corresponding to the data, a FSK demodulator converting the voltage frequency modulation into binary data 61 and transmit to the elements, so that each sensor or module connected to the power source is able to receive or transmit information.

19. Set for calibrating a tube used in apparatus to assist patient's respiration comprising :

- an apparatus according to claim 1 to 6
- a shell (10) with a traversing hole (12) having a known airflow resistance coefficient K_s.